

What is claimed is

1. An optical AND logic gate comprising:
 - i) a summing gate having first and second inputs for receiving first and second optical signals and a first output for summing said first and second optical signals to produce a third signal; and
 - ii) a threshold device having a third input and a second output;
 - iii) said third input of said threshold device arranged to receive from said first output of said summing gate said third signal for producing at said second output of said threshold device a signal corresponding to the AND product of said first and second optical signals.
2. The optical logic gate of claim 1 wherein said summing gate selected from a group of summing gates including dielectric beam splitter, polarization beam splitter, metal beam splitter, dual grating, coupler, directional coupler, and Y-junction coupler.
3. The optical logic gate of claim 1 wherein said summing gate is a non-coherent summing gate.
4. The optical logic gate of claim 1 wherein said summing gate is a coherent summing gate.
5. The optical logic gate of claim 1 wherein said optical logic gate is fabricated on a chip.
6. An optical AND logic gate comprising:
 - i) a combining device having first and second inputs and a first output, said one of said first and second inputs includes an optical delay line;

- ii) a splitting device having first second third and fourth terminals; and
 - iii) a nonlinear element;
 - iv) said third and fourth terminals form an optical loop including said nonlinear element displaced from the center of said optical loop;
 - v) said first and second inputs arranged to receive first and second optical signals for producing a third optical signal at said first output of said combining device;
 - vi) the first terminal of said splitting device arranged to receive said third optical signal from said first output of said combining device for producing at said second terminal a signal corresponding to the AND product of said first and second optical signals.
7. The optical logic gate of claim 6 wherein said nonlinear element is a semiconductor amplifier (SOA).
8. The optical logic gate of claim 6 wherein said optical logic gate is fabricated on a chip.
9. An optical AND logic gate comprising:
- i) a combining device having first and second inputs and a first output, said one of said first and second inputs includes an optical delay line and said first output includes a directing device for directing optical signal returning to said first output into a second output;
 - ii) a splitting device having first second and third terminals; and
 - iii) a nonlinear element;

- iv) said second and third terminals form an optical loop including said nonlinear element displaced from the center of said optical loop;
 - v) said first and second inputs arranged to receive first and second optical signals for producing a third optical signal at said first output of said combining device;
 - vi) the first terminal of said splitting device arranged to receive said third optical signal from said first output of said combining device for producing at said second output a signal corresponding to the AND product of said first and second optical signals.
10. The optical logic gate of claim 9 wherein said nonlinear element is a semiconductor optical amplifier (SOA).
11. The optical logic gate of claim 9 wherein said optical logic gate is fabricated on a chip.
12. The optical logic gate of claim 9 wherein said directing device is selected from a group of directing devices including optical couplers and optical circulators.
13. The optical logic gate of claim 9 wherein said one of said first and second inputs further includes an optical amplifier.
14. An optical AND logic gate comprising:
- i) a combining device having first and second inputs and a first output, said one of said first and second inputs includes an optical delay line and said first output includes a directing device for directing optical signal returning to said first output into a second output;
 - ii) a splitting device having first second and third terminals;

- iii) a nonlinear element; and
- iv) an attenuator;
- v) said second and third terminals form an optical loop including said attenuator and said nonlinear element displaced from the center of said optical loop;
- vi) said first and second inputs arranged to receive first and second optical signals for producing a third optical signal at said first output of said combining device;
- vii) the first terminal of said splitting device arranged to receive said third optical signal from said first output of said combining device for producing at said second output a signal corresponding to the AND product of said first and second optical signals.

15. The optical logic gate of claim 14 wherein said nonlinear element is a semiconductor optical amplifier (SOA).

16. The optical logic gate of claim 14 wherein said optical logic gate is fabricated on a chip.

17. The optical logic gate of claim 14 wherein said directing device is selected from a group of directing devices including optical couplers and optical circulators.

18. The optical logic gate of claim 14 wherein said attenuator is a semiconductor optical amplifier (SOA).

19. An optical NAND logic gate comprising:

- i) An optical AND gate having first and second inputs for receiving first and second optical signals to produce a third optical signal at a first output

corresponding to the AND product of said first and second optical signals;
and

- ii) a coherent summing element having a third input for receiving said third optical signal a fourth input for receiving a continuous beam and a second output for coherently summing said third optical signal and said continuous beam for producing at said second output a signal corresponding to the NAND product of said first and second optical signals.

20. The optical logic gate of claim 19 wherein said optical logic gate further includes means for phase control.

21. The optical logic gate of claim 19 wherein said coherent summing gate selected from a group of summing gates including dielectric beam splitter, polarization beam splitter, metal beam splitter, dual grating, coupler, directional coupler, and Y-junction coupler.

22. An optical NAND logic gate comprising:

- i) An optical AND gate having first and second inputs for receiving first and second optical signals to produce a third optical signal at a first output corresponding to the AND product of said first and second optical signals;
and
- ii) a nonlinear element having a third input for receiving said third optical signal and a forth input receiving a continuous beam for transmitting said continuous beam via said nonlinear element into said third input and said first output;

iii) said first output of said AND gate includes a directing device for directing said continuous beam from said first output into a second output for producing at said second output a signal corresponding to the NAND product of said first and second optical signals.

23. The optical logic gate of claim 22 wherein said nonlinear element is a semiconductor optical amplifier (SOA).

24. The optical logic gate of claim 22 wherein said directing device is selected from a group of directing devices including optical couplers and optical circulators.